"The Future of Wind Energy" with Dr. Robert Gresham

Hello, I'm Kara Lemar. Welcome to the STLE Compass, brought to you by the Society of Tribologists and Lubrication Engineers. The STLE Compass is your convenient and reliable resource for the latest industry developments. This is Episode One of The STLE Compass and today's topic is the future of wind energy.

Wind energy has been a rather hot topic in the field, and has received increased attention and recognition. According to the American Wind Energy Association, the use of wind turbines to generate electric power is growing exponentially. Capacity has more than doubled in the past three years. Annual energy production now is about 2% of worldwide electricity usage. This amount of electricity is dependent upon thousands of wind turbines worldwide.

The leading manufacturer, GE Energy, has more than 13,000 of its most popular units in operation worldwide. In 2009 alone, more than 4,500 wind turbines were installed in the U.S., and this only reflects units made by the top five manufacturers. This rather larger number adds to the tens of thousands of wind turbines already in existence, in the U.S. and worldwide.

To ensure future growth and viability of wind power as an energy source, the industry is looking to tribology and lubrication engineering for guidance on how to solve a number of performance and reliability issues that are challenging wind turbine manufacturers and operators.

Dr. Robert Gresham, STLE's Director of Professional Development, has been an organizer and participant in sessions aimed at exploring and solving these technological problems. He's also written about the subject for STLE's TLT (Tribology & Lubrication Technology) magazine.

As the industry is constantly changing, we wanted to follow up with the most timely information available. We were lucky enough to get a few minutes with Dr. Gresham to catch his expert opinion firsthand. Here is the exclusive telephone interview recorded earlier in the week.

KARA: So Bob, welcome to STLE Compass.

BOB: Thank you.

KARA: How are you doing?

BOB: Doing great.

KARA: Good. So, given your background, what do you consider to be the most important issues facing the wind energy field today?

BOB: Well, as you know Kara, my background is research and development, that's where I spent most of my career and one of the things that we learned, in fact we even had a program for it, is to constantly take a step back and ask yourself, does this make sense? Are we doing the right things? In this case, does creating electricity from wind power make sense? And there are a lot of tough questions that really have not yet been resolved and as we get the answers to these questions we'll be able to find out whether or not, in truth, if this is really a good idea. So let me give you some examples. First we're learning still to build wind turbines in the first place. We're trying to actually measure the loads on the blades, the bearings and so forth and various structural components to try to figure out, you know, whether we're really designing these properly, whether the materials of construction are proper. We're still learning how to make 120 meter long blades for the wind turbines. You think about it, that's a pretty long structure.

KARA: It is.

BOB: How do you make that in a way that is uniform from one end to the other, that there's no structural weaknesses? How do you transport it from one location to another? Usually laying flat on a flatbed truck of a special design but then you ultimately lift it with a crane and hang it by one end, and so suddenly all of the loads and structures on that blade completely change once you hang it on the wind turbine and you've said nothing about when it's actually spinning and turning with variable winds. So there's a lot of construction issues that we're still learning how to work our way through. Pretty critical problem. But these are engineering problems and these are the kinds of things that we know how to do. We also need to learn how to get the wind turbines to last their expected life. This is right now, probably the most serious problem that we have. Currently in the U.S. most of our wind turbines are running about 3-5 years. They were designed to run 20-30. That's a very big difference and a real problem because the maintenance cost on a wind turbine right now is extraordinary. For example, one of the things we've learned is that right now most wind turbines are down at least thirty percent of the time and we've got to do better than that. It costs us on the order of 250-300,000 dollars a day just to bring a crane in to go in and help repair the turbine. That's a lot of money.

KARA: No kidding!

BOB: Yeah. No kidding indeed. And those kinds of expenses just have to go away for this to be a viable alternative. So how do we get repair parts to remote locations? That's another issue. I mentioned earlier the idea of transporting a 120 meter long turbine blade, so how do you do that over rough country or in strange locations? It's a little easier out in the ocean, but still – how do you get parts where they need to go because the parts of these machines are usually quite large? One of the good news aspects of wind turbine technology is that it's relatively inexpensive to build a wind turbine. Their cost is on the order of 1,900 dollars per kilowatt hour. By comparison it costs us about 1,800 dollars a kilowatt hour for coal and nuclear is quite a bit more expensive, on the order of about 9,000 dollars per kilowatt hour. So at least the initial construction part of wind turbine technology is not so bad. The problem is they don't last long enough and they cost a lot to maintain. Those are all engineering problems and I would say, at

least in my opinion, those are all solvable problems. We'll figure out how to do it. I don't know how long it will take, I don't know how much money it will take, but those are the kinds of problems that we know how to figure out. We'll get there.

KARA: Well that's a good thing.

BOB: I think so. Some of the ten ton gorilla problems though, are a little bit different. One in particular is that wind energy can never create all the electrical energy we need. Our goal is 20 percent by the year 2030. The question is given the earlier problems that I've described, is that reasonable or achievable? I don't know. Currently about half of our electrical energy comes by coal, 22 percent from gas, about 20 percent from nuclear, approximately 7 percent from hydro and only 2 percent or so from wind. And as I said before, our goal is to get up on the order of 20 percent by 2030. But the real critical question, the real ten ton gorilla, as I said before, is whether or not the total cost of creating energy by wind, and by total cost I mean the cost that it takes to, or the energy I should say, that it takes to design, manufacture, transport, assemble and maintain wind turbines, is a pretty high number. And if you add upgrades to electricity grids for transmitting that electricity and any needed power plants to offset the times that the wind is literally not blowing, you've spent a lot of money, if you will, or spent a lot of your energy to create this system. So then if you subtract the energy the wind turbine is capable of producing when they're running at an optimum level, is that number positive or negative? And that's a real critical question because if it takes more energy to create electricity by wind than the wind can produce then the result is a net loss and if it's a net loss, that's a serious problem. The current jargon is that wind energy has to be sustainable and what that means is wind energy has to be able to create more energy than it takes to produce it without affecting the environment in any negative way. We don't know the answer to that question and that is the real fundamental question affecting wind energy, at least in my opinion.

KARA: Well that's all good to know. I guess, considering all the different issues that you've talked about that need to be resolved with this technology, what specifically are tribologists focusing on? What have you heard in sessions that you've organized or that you've attended that have come up again and again?

BOB: It's a group effort. We worked in tandem with ASME – the American Society of Mechanical Engineers – as you know we have a joint conference with them, and so they're dealing with some of the mechanical issues. Many of these same folks are also STLE members and so we know them well. So when we talk about tribologists, we're really talking about the community of tribologists in the broad sense of the word, which also includes mechanical engineers, material sciences, all these different kinds of people. We need to have a multi-disciplinary approach to solving the problem. And specifically, with ASME, they're trying to figure out the wear mechanism that's causing the problem in some of the other bearing systems in the wind turbines. It's not a trivial problem but we heard a lot about it at STLE's Annual Meeting last year. They're gearing up to really do that.

The critical issue with micro-pitting, and by that what we mean, it's really the same wear mechanism that happens on the highway. You know, if you have a highway with a lot of trucks going down it, pretty soon what you get is a little micro-cracking and so forth in the concrete and pretty soon that leads to bigger cracks that leads to potholes and pretty soon you've got a real serious problem. But wear and life are similar kinds of things in the bearing life of these big giant bearings. The problem is we don't know exactly what causes that on a wind turbine. We don't know the type of chemical action that might happen that might lead to that. If we understand those different mechanisms, then that tells the people that are producing bearings a little bit about how to use better alloys for the bearings, it might tell the additives people better chemicals to use for the lubricants, it sounds like it would give the condition monitoring and maintenance people insight into what kinds of test to run so they might be able to determine whether we have either the onset of this kind of wear or whether we have lubricant degradation before it actually becomes a problem and if we detect it before it's a problem, then we have relatively cost effective ways of solving these problems without having to go in with a 300 thousand dollar a day crane and those kinds of things. It might be as simple as changing the lubricant or something like that. So that's a critical area and one that tribologists and friends in the industry if you will, can work on together and get the solution to it.

At this year's STLE's Annual Meeting, by design we centered on pretty much one issue and that is the condition monitoring issues. And by that what we're talking about is the real regimen or discipline really of how to look at wind turbines through different tests and samples of one kind or another to determine the health of a machine and how it's running. We heard some really interesting presentations and discussions, and there were a lot of fascinating Q&A debates that went on as well. Some of the key issues were: What are the key properties that we should test for? How do we measure these properties in a wind turbine environment? Remember that wind turbines are pretty big and they're located in some pretty isolated locations. How often should we run these tests? You know, since we try to find a problem before it becomes a problem. Do we need new tests or do we have tests now that tell us what we need to know and we just need to run them, and run them at the right time? And then I think a critical issue for wind turbines is can we automate a lot of this testing? In other words, is it possible to have sensors of one kind or another on the wind turbine that can transmit the results of those tests back to some location where the results can be analyzed in a number of ways and then correct it back, as opposed to having somebody literally climbing up the wind turbine to take a sample or something like that. We really need to be able to do that from a remote location. We know a little bit about how to do that. We don't know enough about how to do that.

KARA: I don't know if I'd want to be the person climbing up to perform tests.

BOB: Especially in the middle of winter in a place like Wyoming or Montana.

KARA: Yeah, that might add some additional problems. But it is good to see that there's a lot of interest and progress being made in the field. On that note, what would you say are some of the key

issues for the industry? Where should tribologists and those involved in wind energy, should they be focusing their energy?

BOB: Well I think first and foremost of course, is to fix these premature bearing fail problems. That probably will have the most impact at least in the short term on the 3-5 year maintenance problem that we have right now. The second area that we have background in is to create the optimum lubricants for the application. That is to harmonize the additives that we use, make sure that we have the right viscosity of oil and that sort of thing so that the lubricant that we're using is the best possible one. And in this application, I think cost is no object because the cost of the machine and the cost of maintenance is so high, that for the formulator, I think it opens the door for him to use really the most exotic solutions that he can come up with. I don't even think we have to worry about toxicity so much and environmental concerns because these are isolated machines and we have sealing technology that can keep whatever chemistry we use pretty much isolated so we can really make a Cadillac solution and not worry about the other kinds of issues that come up with lubricants that are used by the public, where you have health and safety issues and all these other kinds of things that impact the different chemistries that are available to you. So I think they can, essentially, they have almost a blank check to make the best possible product that can be made. Now formulators rarely get that kind of a blank check so if they can figure out what we need, then they can kind of go for it. So that's a good thing.

The next area is we need to learn how to monitor the condition of the machine. And as I mentioned earlier, it needs to be done remotely, and we need to be able to make corrective action before and during severe damage to the machine. We need to literally be able to shut down the machine when something starts to go wrong before it gets in bad shape. I think that's the key. And then take whatever corrective actions are needed so that we minimize our maintenance costs.

KARA: Well, given those issues that you mentioned, the issues that we should be focusing on, has there been any progress made or any major design developments in wind energy technology in the last few months that you've heard about?

BOB: Well, that's a good question because ironically in the last week or two, I've heard of a couple of things, I'm really excited about and I'd like to learn more about it.

The first is an entirely new design where at the top of the tower, we only have the blades and support bearings and the blade shaft in turn is connected to a hydraulic pump, which is a relatively simple device. That hydraulic pump in turn, pumps hydraulic fluid down hydraulic lines running all the way down to the base of the tower where we have the hydraulic fluid reservoir and the motor which in turn is connected to the generator, and so we generate our electricity at the bottom of the tower and not at the top. And what we've effectively done is move a high percentage of our maintenance costs to the bottom of the tower instead of the top of the tower. That should minimize the need for that 300 thousand dollar a day crane that we talked about.

KARA: And no more climbing!

BOB: Well, at least, less climbing let's put it that way. That sounds like a really intriguing idea to me.

The second thing that I heard about that is also a sort of fascinating idea, we haven't talked about it much, but the problem with wind turbines is what happens when there is no wind? Obviously you're not generating electricity. And so you would need to install some kind of backup system or plan to generate electricity when the wind is not blowing. Another way of getting around that problem involves really the technology involved in hydraulics. The idea here is essentially to put a huge hydraulic accumulator in the tower itself. And what an accumulator is, at the risk of being overly simplistic, think about the idea of a tube filled with air and what you do is pump hydraulic fluid into that tube and as you pump it in, it gets higher and higher pressure and then, when you stop pumping it in, that pressure forces that fluid back out of the tube again and the force of that fluid coming out of the tube can be used to do work, in this case, turn the motor that's attached to the generator. So the idea then, is that you have a several hundred meter accumulator or tube if you will, and as the wind turbine functions in the normal fashion as it does now, some hydraulic fluid is also pumped into the accumulator which is building up pressure and at the time the wind stops blowing, what happens is that pressure in the accumulator forces the hydraulic fluid backwards through the system and causes the wind turbine to turn again and in so doing turns the generator. So that's a way of sort of storing extra energy more than what you needed initially to create electricity. It certainly won't solve all the non-wind-blowing problems, but it's a way of ameliorating the problem. I thought sort of a novel idea. Whether that will work or not, is anybody's guess.

KARA: Well, it is good to hear about any new developments and I'm sure that there's going to be a lot more. To wrap up, what would you say are the conclusions or concepts listeners should take away from today's discussion?

BOB: Well the number one issue certainly is to solve our most obvious technical problems that we've gone through today so that we can determine really, whether using wind energy to generate a part of our electrical needs is a sustainable solution. And that's really it. Does this actually make sense or not? Is this a net gain for society or a net loss? So what we have to do is evolve enough in these technical issues to see whether wind energy can stand on its own two feet without being propped up by the local government, whoever that might be.

KARA: Well that leaves us all with something to think about. The field needs to answer some key questions about wind energy before we can determine its future. Thank you Dr. Gresham for joining us today and for your insight.

BOB: Thank you. It's been fun and I hope it's been helpful.

KARA: I'm Kara Lemar. For more news and information on wind energy, you can visit our website at www.stle.org. Thank you for joining us today. This has been another episode of The STLE Compass, pointing you in the right direction.